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Influence of ice particle model on satellite ice cloud retrieval: lessons learned from MODIS and POLDER cloud product comparison

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Abstract. The influence is investigated of the assumed ice particle microphysical and optical model on inferring ice cloud optical thickness (τ) from satellite measurements of the Earth's reflected shortwave radiance. Ice cloud τ are inferred, and subsequently compared, using products from MODIS (MODerate resolution Imaging Spectroradiometer) and POLDER (POLarization and Directionality of the Earth's Reflectances). POLDER τ values are found to be substantially smaller than those from collocated MODIS data. It is shown that this difference is caused primarily by the use of different ice particle bulk scattering models in the two retrievals, and more specifically, the scattering phase function. Furthermore, the influence of the ice particle model on the derivation of ice cloud radiative forcing (CRF) from satellite retrievals is studied. Three sets of shortwave CRF are calculated using different combinations of the retrieval and associated ice particle models. It is shown that the uncertainty associated with an ice particle model may lead to two types of errors in estimating CRF from satellite retrievals. One stems from the retrieval itself and the other is due to the optical properties, such as the asymmetry factor, used for CRF calculations. Although a comparison of the CRFs reveals that these two types of errors tend to cancel each other, significant differences are still found between the three CRFs, which indicates that the ice particle model affects not only optical thickness retrievals but also CRF calculations. In addition to CRF, the effect of the ice particle model on the derivation of seasonal variation of τ from satellite measurements is discussed. It is shown that optical thickness retrievals based on the same MODIS observations, but derived using different assumptions of the ice particle model, can be substantially different. These differences can be divided into two parts. The first-order difference is mainly caused by the differences in the asymmetry factor. The second-order difference is related to seasonal changes in the sampled scattering angles and therefore dependent on the sun-satellite viewing geometry. Because of this second-order difference,

the use of different ice particle models may lead to a different understanding of the seasonal variation of τ.

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